430 Rec'd PCT/PTO 11 FEB 2000

FORM PTO-1390 (REV. 5-93) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 2345/113
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/485596

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED:
PCT/EP98/04434	(16.07.98) 16 July 1998	(13.08.97) 13 August 1997

TITLE OF INVENTION
METHOD AND CIRCUIT ARRANGEMENT FOR TRANSMITTING MESSAGES

APPLICANT(S) FOR DO/EO/US
HUBER, Klaus and HOFMANN, Karl-Heinrich

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2))
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: Preliminary Examination Report

EXPRESS MAIL NO. EL179105419

U.S. APPLICATION NO. if known, see 37 C.F.R.1.5	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/485598	PCT/EP98/04434	2345/113

17. ☒ The following fees are submitted:

	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO .... $840.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) ... $670.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) .... $760.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO .... $970.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $96.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 840	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	11 - 20 =	0	X $18.00	$ 0	
Independent Claims	2 - 3 =	0	X $78.00	$ 0	
Multiple dependent claim(s) (if applicable)			+ $260.00	$ 0	

	CALCULATIONS	PTO USE ONLY
TOTAL OF ABOVE CALCULATIONS =	$ 840	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28)	$	
SUBTOTAL =	$ 840	
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +	$	
TOTAL NATIONAL FEE =	$ 840	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +	$	
TOTAL FEES ENCLOSED =	$ 840	
	Amount to be: refunded	$
	charged	$

a. ☐ A check in the amount of $__________ to cover the above fees is enclosed

b. ☒ Please charge my Deposit Account No. 11-0600 in the amount of **$ 840.00** to cover the above fees. A duplicate copy of this sheet is enclosed

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status

SEND ALL CORRESPONDENCE TO:

Kenyon & Kenyon
One Broadway
New York, New York 10004

[signature]
SIGNATURE

Richard L. Mayer, Reg. No. 22,490
NAME

2/11/00
DATE

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[2345/113]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: HUBER et al.

SERIAL NO.: to be assigned

FILED: herewith

TITLE: METHOD AND CIRCUIT ARRANGEMENT FOR TRANSMITTING MESSAGES

ART UNIT: not yet known

EXAMINER: not yet known

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Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

PRELIMINARY AMENDMENT

Please amend the above-identified application before a first consideration on the merits as follows:

IN THE SPECIFICATION

On page 1, before line 1, insert --Field of the Invention--.

On page 1, line 1, before "invention" insert --present-- and after "method" insert --and circuit arrangement--.

On page 1, line 2, delete "The invention also relates to a circuit".

On page 1, delete line 3.

On page 1, before line 5, insert --Related Technology--.

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On page 1, line 5, change "of this type are known from the related art" to --for transmitting messages using coding by orthogonal functions have been used--.

On page 1, line 9, after "1965" insert --, which is herewith incorporated by reference herein,--.

On page 1, before line 10, insert --A method and a device for transmitting messages using Hermite functions as orthogonal functions are described in European Patent Document No. EP 0 340 853.--.

On page 1, before line 14, insert --<u>Summary of the Invention</u>--.

On page 1, line 14, change "The object" to --An object--, after "method" insert --and circuit arrangement-- and change "permits" to --permit--.

On page 1, replace line 17, with "This objective is achieved by a method having the features of Claim 1. Because so-" to --The present invention provides a method for transmitting at least one message, the method including coding each of the at least one message using a respective orthogonal function so as to form a transmission signal, each respective orthogonal function being an approximation of a respective Hermite function. A Fourier transform is performed on a received signal, and then the Fourier transformed received signal is decoded using the respective orthogonal function so as to obtain the at least one message. Use is made of the property that, except for a multiplicative constant, Hermite functions do not change during a Fourier transform--.

On page 1, delete lines 18-19.

On page 1, line 21, before "invention" insert --present--.

On page 1, line 26, before "invention" insert --present--.

On page 2, replace lines 17-23 with --The present invention also provides a circuit arrangement for transmitting at least one message, the circuit arrangement including a coding device at a transmission side for coding each of the at least one message using a respective orthogonal function so as to form a transmission signal, each respective orthogonal function being an approximation of a respective Hermite function. A demodulation device is included at a receiving side for recovering the at least one message from a received signal via a decoding using the respective Hermite function. The demodulation device includes a Fourier-transform device for performing a Fourier transform on the

received signal before the decoding.--.

On page 2, line 25, before "invention" insert --present--.

On page 2, line 28, change "Multiplier and" to --A multiplier and an--.

On page 3, delete lines 1-3.

On page 3, line 5, before "invention" insert --present--.

On page 3, before line 11, insert --<u>Brief Description of the Drawings</u>--.

On page 3, line 11, before "invention" insert --present--.

On page 3, line 12, change "drawing" to --drawings--.

On page 3, before line 24, insert --<u>Detailed Description</u>--.

On page 3, line 27, change ", a number of L multipliers 9 which" to --a number L, of multipliers 9, which--.

On page 4, line 25, change "of L" to --L of--.

On page 6, line 11, after "1988" insert --, which is herewith incorporated by reference herein,--.

On page 8, line 12, change "essentially" to --fundamentally--.

On page 9, line 1, change "Patent Claims" to --WHAT IS CLAIMED IS:--.

<u>IN THE CLAIMS</u>

Please cancel without prejudice claims 1-12 and the substitute claims 1-10 annexed to the International Preliminary Examination Report, and add new claims 13-23 as follows:

--13. (new) A method for transmitting at least one message, the method comprising:

coding each of the at least one message using a respective orthogonal function so as to form a transmission signal, each respective orthogonal function being an approximation of a respective Hermite function;

performing a Fourier transform on a received signal; and

then decoding the Fourier transformed received signal using the respective orthogonal function

so as to obtain the at least one message.

14. (new) The method as recited in claim 13 further comprising filtering the received signal at least one of before and after the performing of the Fourier transform.

15. (new) The method as recited in claim 14 wherein the filtering includes a low-pass filtering.

16. (new) The method as recited in claim 13 wherein the decoding is performed in both a time domain and a frequency domain.

17. (new) The method as recited in claim 16 wherein the decoding provides at least a time domain result and a frequency domain result and further comprising applying a metric to the time domain result and the frequency domain result so as to select one of the results.

18. (new) The method as recited in claim 17 wherein the metric includes a Euclidian metric.

19. (new) The method as recited in claim 13 further comprising modulating the transmission signal into higher frequency domains.

20. (new) A circuit arrangement for transmitting at least one message, the circuit arrangement comprising:

a coding device at a transmission side for coding each of the at least one message using a respective orthogonal function so as to form a transmission signal, each respective orthogonal function being an approximation of a respective Hermite function; and

a demodulation device at a receiving side for recovering the at least one message from a received signal via a decoding using the respective Hermite function, the demodulation device including a Fourier-transform device for performing a Fourier transform on the received signal before the

decoding.

21. (new) The circuit arrangement as recited in claim 20 wherein the demodulation device further includes a respective first decoder unit corresponding to each of the at least one message, each respective first decoder unit including a respective first multiplier, a respective first integrator and a respective first discriminator connected in series.

22. (new) The circuit arrangement as recited in claim 21 wherein each respective first decoder unit is for decoding the signal in a time domain and wherein the demodulation device further includes a respective second decoder unit associated with each respective first decoder unit, each respective second decoder unit being for decoding the signal in a frequency domain and including a respective second multiplier, a respective second integrator and a respective second discriminator connected in series.

23. (new) The circuit arrangement as recited in claim 20 wherein the demodulator further includes a respective discriminator corresponding to each of the at least one message and a respective first and second evaluator unit connected to each respective discriminator, the first evaluator unit for decoding the signal in a time domain and including a respective first multiplier and a respective first integrator connected in series, the second evaluator unit for decoding the signal in a frequency domain and including a respective second multiplier and a respective second integrator connected in series--.

IN THE ABSTRACT

Line 1, change "The method relates to the" to --A method and circuit arrangement for--.

Replace line 4 with --A Fourier transform is performed on the received signal and subsequently decoded with the aid of the orthogonal functions.--.

REMARKS

This Preliminary Amendment cancels original claims 1-12 in the underlying PCT Application No. PCT/EP98/04434 and the substitute claims 1-10 annexed to the International Preliminary Examination Report (a translation of which is submitted herewith), and adds new claims 13-22. The new claims do not add new matter to the application but do conform the claims to U.S. Patent and Trademark Office rules.

The amendments to the specification and abstract are to conform the specification and abstract to U.S. Patent and Trademark Office rules. It is respectfully submitted that the amendments to the specification and abstract do not introduce new matter into the application.

The underlying PCT application includes a Search Report, a copy of which is included herewith.

Conclusion

Consideration of the present application as amended is hereby respectfully requested.

Respectfully Submitted,

Kenyon & Kenyon

Dated: 2/11/00

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METHOD AND CIRCUIT ARRANGEMENT FOR TRANSMITTING MESSAGES

The invention relates to a method for transmitting messages, the messages being coded by orthogonal functions to form a signal. The invention also relates to a circuit arrangement for carrying out the method.

Methods of this type are known from the related art. Thus, in practice, frequent use is made of sinusoidal and cosinusoidal functions as orthogonal base functions for coding a number of messages to form a common signal. Reference is made to the book entitled *"Principles of Communication Engineering"*, Wozencraft, Jacobs, Wiley, New York 1965 for the theory of these methods.

The aim in transmitting messages is to make the signals to be transmitted immune to interference and to provide means at the receiving side which filter out interference.

The object of the present invention is to specify a method which permits a high transmission rate in conjunction with a reduction in the interference susceptibility.

This objective is achieved by a method having the features of Claim 1. Because so-called Hermite functions are used as orthogonal functions, the interference can be reduced substantially at the receiving side.

In an advantageous further development of the invention, the received signal is subjected to a Fourier transform and subsequently decoded with the aid of the Hermite functions. In this case, use is made of the property that, except for a multiplicative constant, Hermite functions do not change during a Fourier transform.

An advantageous further development of the invention provides for the received signal to be filtered before and/or after the Fourier transform, in order to eliminate

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possibly included interference components.

In one advantageous further development of the invention, the received signal is decoded both in the time domain and in the frequency domain. That is to say, on the one hand, the received signal is fed directly to the decoding and, on the other hand, is first of all subjected to a Fourier transform and then decoded.

In an advantageous further development of the invention, in each case one of the two decoded signals in the time domain and in the frequency domain, respectively, is selected.

One advantageous further development of the invention provides for one of the two signals present in the time domain and in the frequency domain to be selected on the basis of all signals present.

The objective of the invention is also achieved by a circuit arrangement having the features of Claim 1. The circuit arrangement is designed for the purpose of carrying out the method according to the invention. To that end, at the transmitting side, the circuit arrangement has a modulation device which, with the assistance of Hermite functions, codes the messages to be transmitted. Provided correspondingly at the receiving side is a demodulation device which decodes the messages from the received signals with the aid of the Hermite functions.

In an advantageous further development of the invention, the demodulation device has a number of multipliers, integrators and discriminators corresponding to the number of dimensions or linear factors, one multiplier, one integrator and one discriminator, respectively, being connected in series to form an evaluation unit. Multiplier and integrator form a correlator.

In one advantageous further development of the invention, provision is made for a Fourier-transform device which subjects the received signal to a Fourier transform and

feeds it to the evaluation units.

In another advantageous further development of the invention, each evaluation unit is provided in duplicate, in which case one of the two evaluation units is fed the signal in the time domain, and the other evaluation unit is fed the signal in the frequency domain. Instead of two evaluation units, it is optionally possible to use only one with a multiplex technique.

The invention will now be explained in more detail on the basis of exemplary embodiments with reference to the drawing, in which:

Figure 1	shows a schematic representation of a first exemplary embodiment of a circuit arrangement;
Figure 2	shows a schematic representation of the receiving side of a further exemplary embodiment;
Figure 3	shows a schematic representation of the receiving side of a further exemplary embodiment;
Figure 4	shows a schematic representation of the receiving side of a further exemplary embodiment; and
Figure 5	shows a graphical representation of the first five Hermite functions.

Figure 1 shows a circuit arrangement which is suitable for transmitting and receiving messages. It includes a transmitting device 3 which transmits signals to a receiving device 7, for example, via a transmission channel 5. Transmitting device 3 includes a plurality of, in the present exemplary embodiment, a number of L multipliers 9 which, with the aid of orthogonal functions $f_0(t)$ to $f_{L-1}(t)$, map the message $\underline{m} = (m_0,...,m_{L-1})$ to be coded. The output signals of multipliers 9 are fed to an adding device 11 which generates signal s(t) to be transmitted. Signal s(t) can therefore be represented as a linear combination of orthogonal base functions as follows:

$$s(t) = m_0\, f_0(t)+m_1\, f_1(t)+..+m_{L-1}\, f_{L-1}(t).$$

Functions $f_0(t)$ to $f_{L-1}(t)$ are orthogonal functions which satisfy the following rule:

$$\int_{-T/2}^{+T/2} f_i(t)\, f_j(t)\, dt = \begin{cases} const & i = j \\ 0 & otherwise \end{cases},$$

T being the orthogonality interval. Since the orthogonality interval of the Hermite functions extends over an infinite time interval, the Hermite functions must be approximated by technically realizable functions.

Functions f(t) are usually standardized in such a way that the constant is equal to 1. The term orthonormal functions is also used in this case.

It is indicated in Figure 1 that signal s(t) to be transmitted encounters interference on transmission path 5, the interference signal being denoted by e(t).

Receiving device 7 includes a number of decoder units 13 corresponding to the number of the dimensions contained in signal s(t). In the present exemplary embodiment, a number of L decoder units 13 is provided. Each of decoder units 13 includes a multiplier 15, an integrator 17 and a discriminator 19. The aforesaid subassemblies are connected in series, the output signal of multiplier 15 being fed to the integrator, and the output signal of the integrator being fed to discriminator 19, which then provides the decoded component $\hat{m}_j$.

Each of decoder units 13 is fed a signal r(t) which is composed of transmitted signal s(t) and interference signal e(t). Owing to the orthogonality of the functions used for modulation, components m_j can be recovered from transmitted signal s(t) in a simple manner by calculating the integral

$$\int_{-T/2}^{+T/2} s(t)\, f_j(t)\, dt$$

This integration is carried out by integrators 17. Since signal r(t) received by receiving device 7 has an interference component e(t), the signal made available by integrators 17 in accordance with the equation

$$\int_{-T/2}^{+T/2} r(t)\, f_j(t)\, dt$$

where r(t) = s(t) + e(t)

also contains an interference component. The downstream discriminator 19 now has the task of determining the best possible estimated value for message m_j from the defective signal supplied by integrator 17.

In addition to the already mentioned property of orthogonality, functions $f_0(t)$ to $f_{L-1}(t)$ used for modulation are distinguished by the fact that they remain unchanged in the case of a Fourier transform, except for a multiplicative constant. Such functions are the Hermite functions, and are defined as follows:

$$f_n(X) = \frac{H_n(X)\, e^{\frac{-x^2}{2}}}{\sqrt{2^n n!}\sqrt{\pi}}$$

$H_n(x)$ being the Hermite polynomials, for which it holds that:

$$H_n(X) = (-1)^n e^{x^2} \frac{d^n}{dx^n} e^{-x^2}$$

A graphical representation of the first five Hermite functions is shown in Figure 5.

The strong exponential decay of the functions is clearly to be seen. This property permits, in a simple way, a technically realizable approximation of the functions which are then fed to multipliers 9 and 15. A detailed description of the mentioned Hermite functions can be found in the book entitled *"The Fourier Integral and Certain of Its Applications"*, N. Wiener, Cambridge University Press, Cambridge 1933, reprinted 1988.

Figure 2 shows a second exemplary embodiment of a receiving device 7, which corresponds essentially to the receiving device described and shown in Figure 1. A description of the parts marked with the same reference symbols is therefore dispensed with. By contrast with receiving device 7 already described, in the present exemplary embodiment, provision is made for a Fourier-transform device 21 which transforms received signal r(t) into the frequency domain and then feeds this transformed signal to multipliers 15. A first filter 22.1 is connected upstream of Fourier-transform device 21, and a second filter 22.2 is connected downstream of it. The schematically illustrated switches S are intended to indicate that the two filters 22.1, 22.2 can be used optionally. The two filters themselves are preferably low-pass or band-pass filters.

Because signal s(t) containing the message is represented in the base band as a linear combination of Hermite functions, this signal s(t) is essentially not changed by the Fourier transform of Fourier-transform device 21. The result of this is that decoder units 13 can be designed in accordance with the decoder units specified in Figure 1. Functions $F_0(f)$ to $F_{L-1}(f)$ fed to multipliers 15 differ from time functions $f_0(t)$ to $f_{L-1}(t)$ specified in Figure 1 only by a multiplicative constant whose value is equal to +/-1 or +/-i, i being the root of -1, provided that the Fourier transform is defined, as in the book by Wiener, as

$$F(f) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{+\infty} f(t)\, e^{-ift}\, dt$$

Other definitions of the Fourier transform are likewise possible, mutatis mutandis. The definition used here is the mathematically simplest one in this case. Note, however, that the symbol f differs by a factor from the customary frequency.

The interference e(t) contained in received signal r(t) can be filtered out to a certain extent by filter 22.1 upstream of Fourier-transform device 21, the signal components of the orthogonal Hermite functions remaining essentially unchanged. A contribution to further reducing the interference component is made by second filter 22.2, which is connected downstream of Fourier-transform device 21 and eliminates further interference components by a further filtering operation.

A further exemplary embodiment of a receiving device 7 is shown in Figure 3. The design corresponds essentially to that of the receiving device according to Figure 2, so that a repeated description of the parts marked with the same reference symbols is omitted. In contrast with the above-named exemplary embodiment, in each case two units, composed of a multiplier 15 and integrator 17, are allocated to each discriminator 19. In each case, one of these units 23 is fed signal r(t) directly, while the respective other unit 25 receives the output signal of Fourier-transform device 21. The result of this is therefore a combination of receiving devices 7 shown in Figure 1 and in Figure 2, discriminator 19 being required to fulfil the task of selecting the best of the two fed output signals of integrators 17 and making it available as components $\hat{m}_j$. Discriminator 19 determines the best estimated value from the two fed signals in the time domain and in the frequency domain on the basis of a suitable metric, for example, the Euclidian metric.

Shown in Figure 4 is a further exemplary embodiment of receiving device 7 which corresponds essentially to the exemplary embodiment according to Figure 3. By contrast, in receiving device 7 according to Figure 4, a discriminator 19' is provided to which is fed the output signals of all the integrators 17 and which, on the basis of all the signals, estimates and outputs components m_0 to M_{L-1} using a suitable metric, for example, the Euclidian metric, once again. This receiving device makes it possible for

components $\hat{m}_0$ to $\hat{m}_{L-1}$, decoded from disturbed signal r(t), to have a very small interference component.

It is common to all the above-mentioned exemplary embodiments that an additional filtering can be performed in the frequency domain owing to the use of Hermite functions to code the message, because these Hermite functions are not essentially changed by the Fourier transform. Thus, interference in the decoded messages is reduced.

Of course, it is possible to combine individual exemplary embodiments; for example, the two filters 22.1, 22.2 shown in Figure 2 can also be used in the exemplary embodiments according to Figures 3 and 4. Moreover, it is conceivable for signal s(t) to be transformed into higher frequency domains in a known way by modulation. It is also conceivable for the exemplary embodiment shown in Figure 3 to be modified in such a way that, instead of two respective units 23, provision is made for only one unit 23 which is then alternately fed, via a multiplexer, the signal in the time domain and the signal in the frequency domain.

Patent Claims

1. A method for transmitting messages, the messages $\underline{m}=(m_0, m_1,\ldots,m_{L-1})$ being coded by orthogonal functions to form a signal $(s(t))$, characterized in that approximations of Hermite functions are used as orthogonal functions.

2. The method as recited in Claim 1, characterized in that the received signal is subjected to a Fourier transform and subsequently decoded with the aid of the Hermite functions in order to obtain the messages.

3. The method as recited in Claim 2, characterized in that the received signal is filtered, preferably low-pass filtered, before and/or after the Fourier transform.

4. The method as recited in one of the preceding claims, characterized in that the received signal is decoded both in the time domain and in the frequency domain.

5. The method as recited in Claim 4, characterized in that each component m_j is decoded both in the time domain and in the frequency domain, and in that after the results are obtained, a discriminator is used to select the respective best received value along the lines of a suitable metric.

6. The method as recited in Claim 5, characterized in that the discriminator selects the m_j as a function of all $\hat{m}_j$ with the aid of a suitable criterion.

7. The method as recited in one of the preceding claims, characterized in that the signal is transformed

by modulation into higher frequency domains.

8. The method as recited in Claim 5 or 6, characterized in that the Euclidian metric is used to determine the best signal to be selected.

9. A circuit arrangement for transmitting messages, a number of L components ($m_0 \dots m_{L-1}$) being coded by orthogonal functions to form a signal, characterized in that provision is made on the transmitting side for a coding device (3) which codes the messages (m) by approximated Hermite functions, and in that provision is made on the receiving side for a demodulation device (7) which recovers the messages from the received signal (r(t)) with the aid of the approximated Hermite functions.

10. The circuit arrangement as recited in Claim 9, characterized in that the demodulation device (7) has a number L of multipliers (15), integrators (17) and discriminators (19) which corresponds to the number of the components, one modulator, one integrator and one discriminator, respectively, being connected in series to form a decoder unit (13).

11. The circuit arrangement as recited in Claim 9 or 10, characterized in that a Fourier-transform device (21) is provided which subjects the received signal (r(t)) to a Fourier transform and feeds it to the decoder units (13).

12. The circuit arrangement as recited in one of Claims 9 through 11, characterized in that each decoder unit (13) is provided in duplicate, one decoder unit decoding the signal in the time domain, and the respective other decoder unit decoding the signal in the frequency domain.

Abstract

The method relates to the transmission of messages in which a number of L components ($m_0,\ldots,m_{L-1}$) are coded by means of orthogonal functions to a signal ($s(t)$), and in which approximations of hermitic functions are used as orthogonal functions. The invention further relates to the circuit layout in order to carry out said method.

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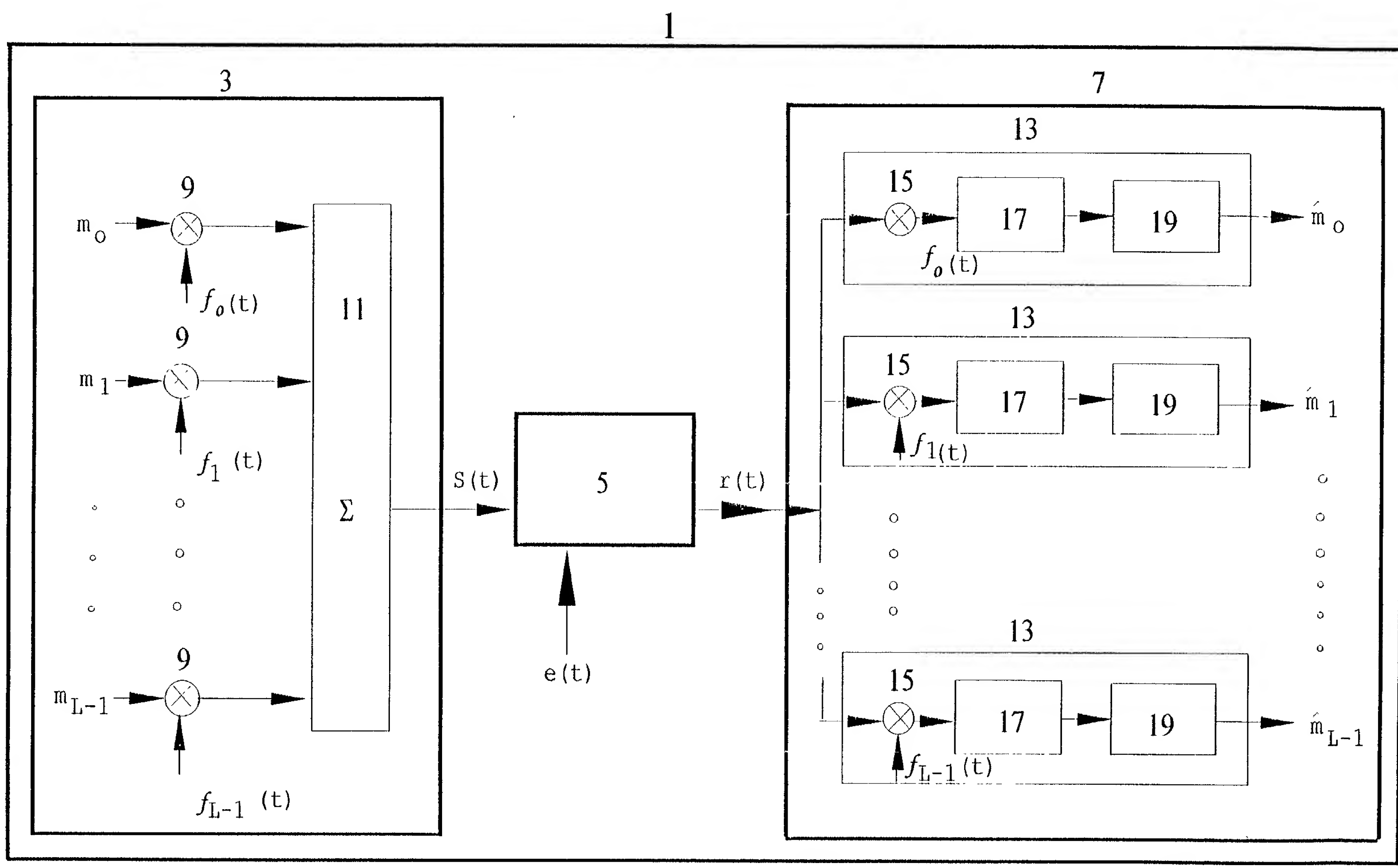

Fig. 1

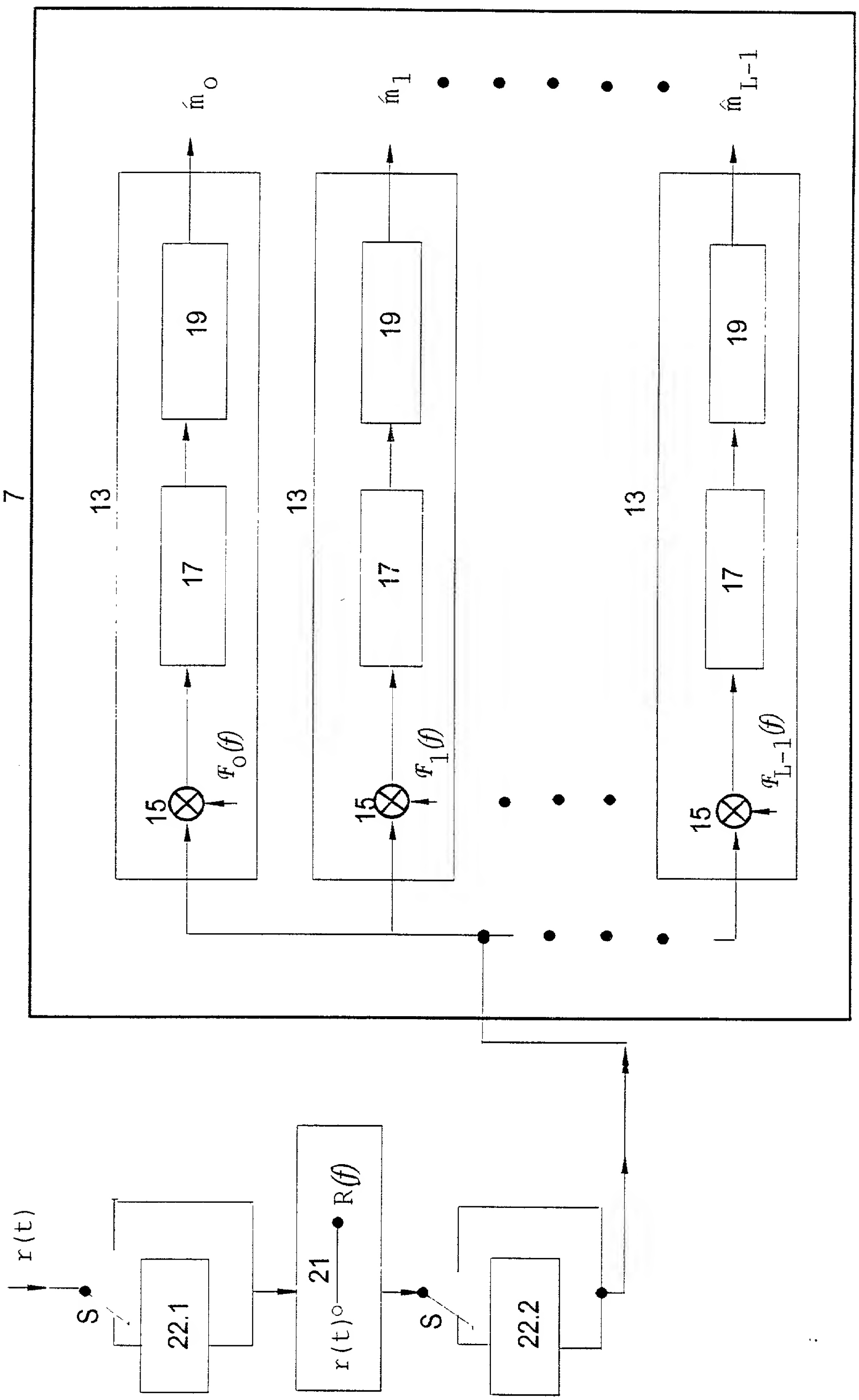

Fig. 2

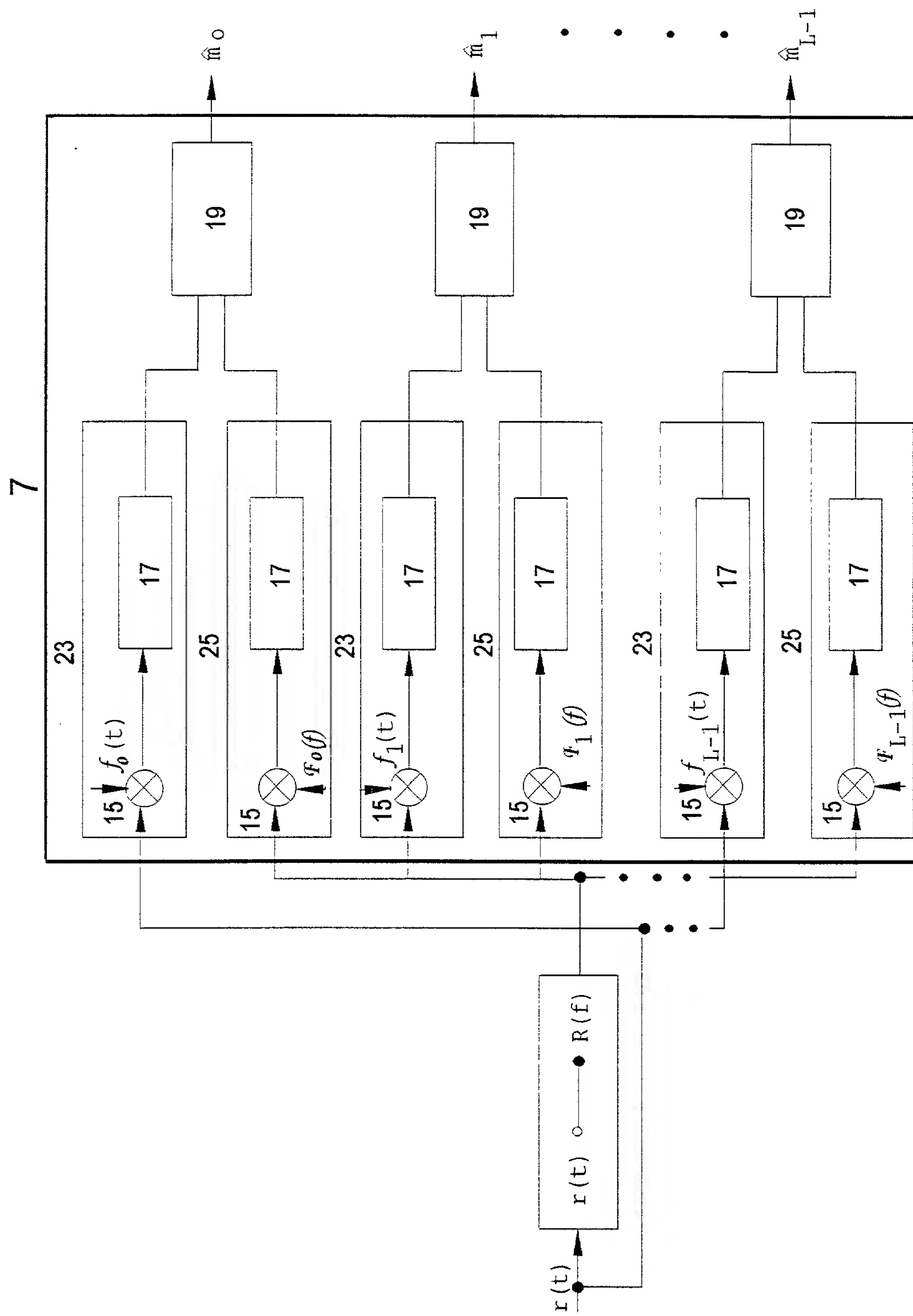

Fig.3

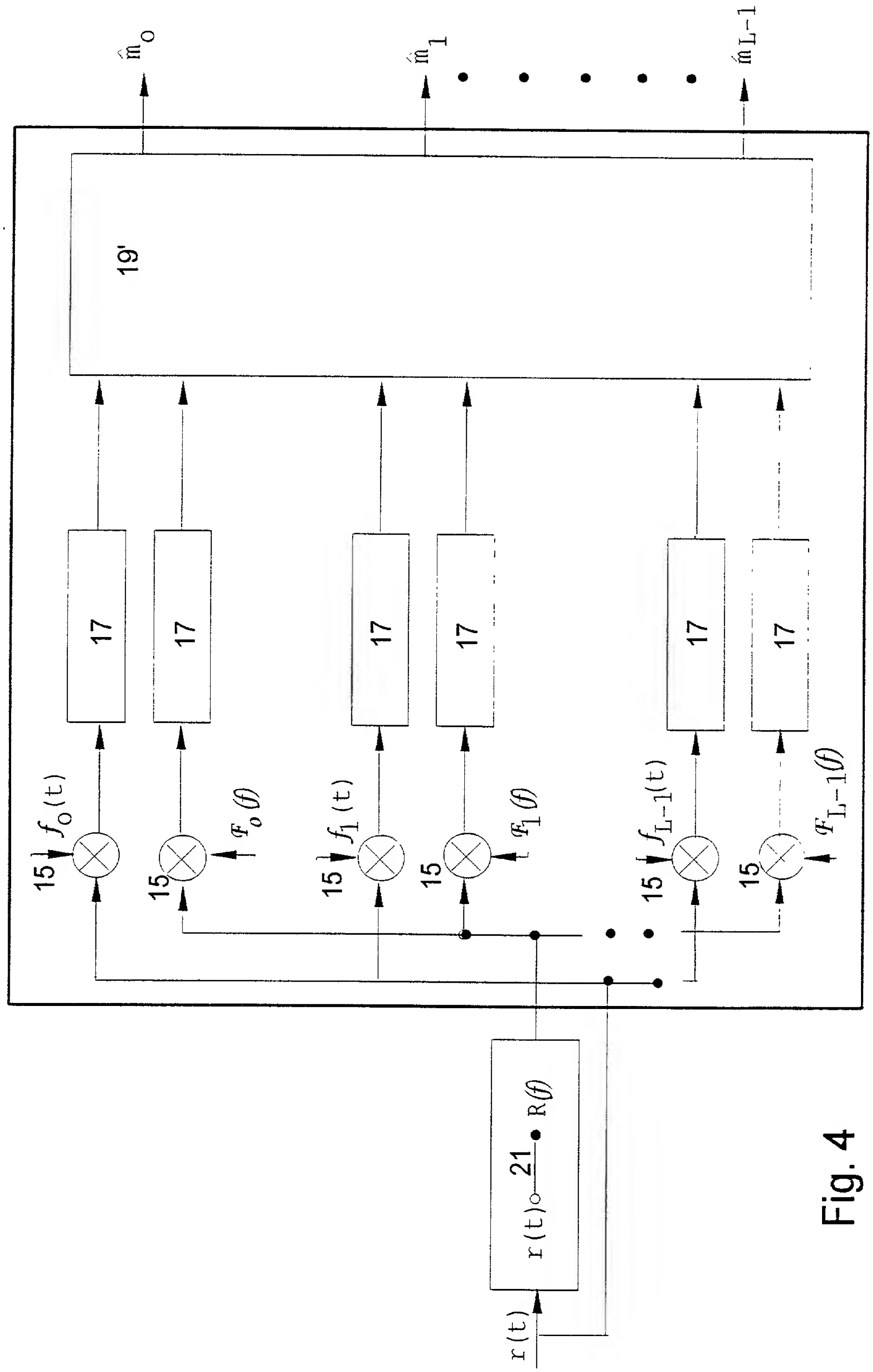

Fig. 4

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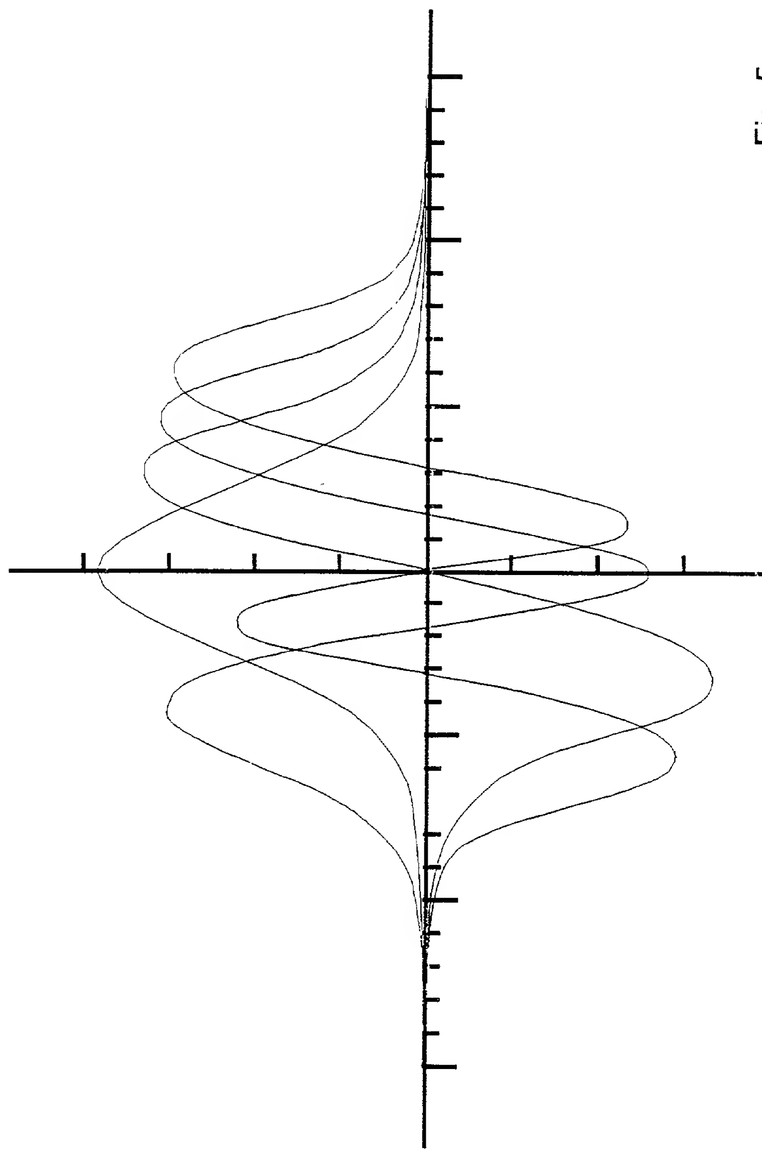

Fig. 5